IN MEMORIAM

C. WALTON LILLEHEI (1918-1999)

The world of cardiac surgery has lost a pioneer with the passing of Dr C. Walton Lillehei. Dr Lillehei was 80 years old when he died at home of prostate cancer July 5, 1999.

Many of today's cardiac surgeons believe that Dr Lillehei should be credited with the success of modern open heart surgery. Although John Lewis closed simple atrial septal defects using immersion hypothermia in 1952 and John Gibbon repaired an atrial septal defect in 1953 using a screen oxygenator, progress in open heart surgery stalled because of repeated failure of the pump-oxygenator and the widespread acceptance of the "sick human heart" theory, which held that open heart surgery would be impossible without an artificial heart to support postoperative recovery. In this atmosphere of despair, Lillehei's cross-circulation technique startled the medical world with reproducible success in very ill patients with complex cardiac lesions. The results of cross-circulation repair of intraventricular defects quickly reversed the pessimism attending open heart surgery in the 1950s.

Lillehei and his team first repaired a ventricular septal defect at the University of Minnesota on March 26, 1954. During the next 15 months, 45 patients with major intracardiac malformations, most heretofore uncorrectable, underwent repair with cross-circulation between parent and patient. Because Dr Lillehei was the only surgeon repairing complicated cardiac defects with the use of cross-circulation, he was able to rapidly refine operative techniques to improve outcome. Heart block was a leading cause of death among early patients having ventricular septal defect closure. To overcome this life-threatening bradycardia, Dr Lillehei developed a method of direct myocardial stimulation with an external pacemaker and myocardial electrode. The first human application of this pacemaker system occurred January 10, 1957, at the University of Minnesota Hospital. Dr Lillehei subsequently initiated research and development of a small portable external pacemaker that ultimately grew into Minnesota's billion-dollar pacemaker industry.

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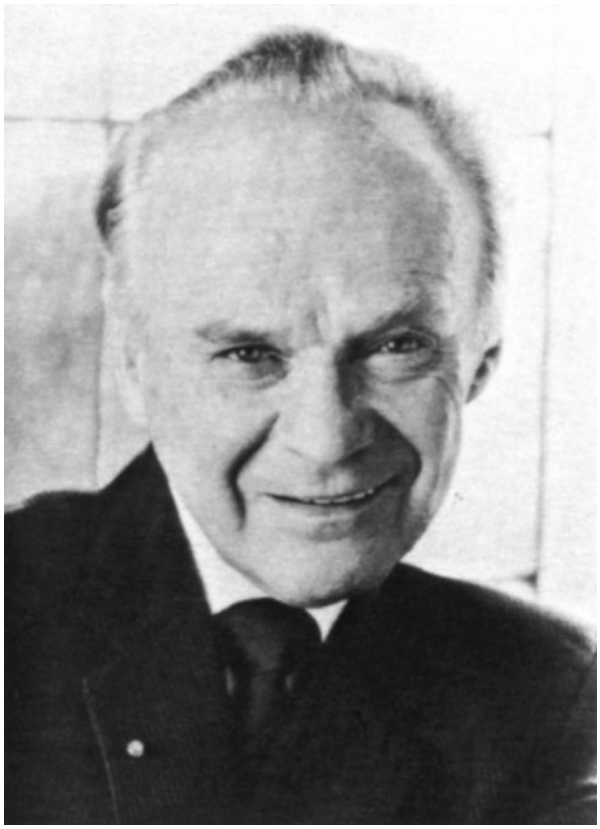

Working with Dr Richard DeWall, Dr Lillehei developed the first clinically successful bubble oxygenator, which later supplanted cross-circulation in 1955. The DeWall-Lillehei oxygenator spurred tremendous growth of open heart surgery programs throughout the world in the late 1950s.

Empowered by his new oxygenator, Dr Lillehei pioneered surgical management of acquired valvular heart disease in adults. For the first time, regurgitant valves could be repaired and stenotic valves opened more completely and precisely. Valves that defied reconstruction stimulated research to devise prostheses. Several mechanical heart valves designed and developed in Dr Lillehei's laboratory were commercially manufactured and used clinically, including the Lillehei-Kaster pivoting disc valve and the Kalke-Lillehei bileaflet cardiac valve, a forerunner of the St Jude Medical valve.

Dr Lillehei further expanded his contribution to medicine by training 134 cardiothoracic surgeons at the University of Minnesota Hospital and an additional 20 surgeons at the Cornell University Medical Center. Prospective trainees came from all areas of the world and included Drs Norman Shumway, Christiaan Barnard, Herbert Warden, Morley Cohen, and Richard DeWall. Twenty-three of his 154 trainees became program directors of cardiothoracic programs; they in turn trained 477 surgeons. By 1988, at least 820 cardiothoracic surgeons in 36 countries could trace their preceptoral heritage back to Dr Lillehei. Now, 11 years later, that number must be greater by several hundred.

Dr Lillehei's many achievements have been recognized by more than 90 international awards and honors. Foremost among them was the 1955 Lasker Award, which he shared with Drs Varco, Cohen, and Warden. Other outstanding achievements were the Harvey Prize in Science and Technology awarded by Technion in Israel in 1996 and the Hektoen Gold Medal from the American Medical Association in 1957. Dr Lillehei was the only living surgeon to be recognized by a festschrift issue of *The Journal of Thoracic and Cardiovascular Surgery.* Published in November 1989, it contained scientific papers presented on the occasion of his 70th birthday. At that meeting, his former students and associates established the C. Walton and Richard C. Lillehei Professorship in Cardiovascular Surgery at the University of Minnesota.

Dr Lillehei was born in Minneapolis on October 23, 1918. He graduated from the University of Minnesota Medical School in 1942 and served in the US Army in the African and Italian theaters from June 1942 to February 1946. He completed his surgical training under Dr Owen H. Wangensteen at the University of Minnesota and became a clinical instructor in the Department of Surgery there in July 1951. He became a professor in the same department in June 1956. In November 1967, he was appointed the Lewis Atterbury Stimson Professor of Surgery and chairman of the Department of Surgery at the New York Hospital–Cornell Medical Center. He held that position until 1974. He later returned to Minnesota and was appointed clinical professor in the Department of Surgery, University of Minnesota Hospital, in 1986. In 1970, he became director of medical affairs for St Jude Medical, Incorporated, a position he held until his death.

Dr Lillehei was honored last October by an 80th birthday festschrift in Minneapolis. Many of his trainees, colleagues, friends, and family gathered to pay tribute to the man who had profoundly influenced their lives. The scientific papers presented at the Lillehei 80th festschrift will be published later this year in a special issue of *The Annals of Thoracic Surgery.*

Dr Lillehei is survived by his wife of 52 years, Kaye Lindberg Lillehei; a daughter, Kimberle Loken, of Duluth, Minnesota; and two sons, Dr Craig Walton Lillehei, assistant professor of pediatric surgery at Boston Children's Hospital, and Dr Kevin Owen Lillehei, associate professor of neurosurgery at the University of Colorado.

Dr Lillehei was a "surgical giant" of the 20th century and he will be missed by us all. As cardiothoracic surgeons, we are indebted to him for his monumental contributions to our specialty. Worldwide, millions of patients with implantable pacemakers and prosthetic valves owe their lives to him. But his greatest legacy may be the generations of surgeons he educated, inspired, and encouraged, who will advance the surgical treatment of heart disease into the next millennium.

Vincent L. Gott, MD